United States
Environmental Protection
Agency

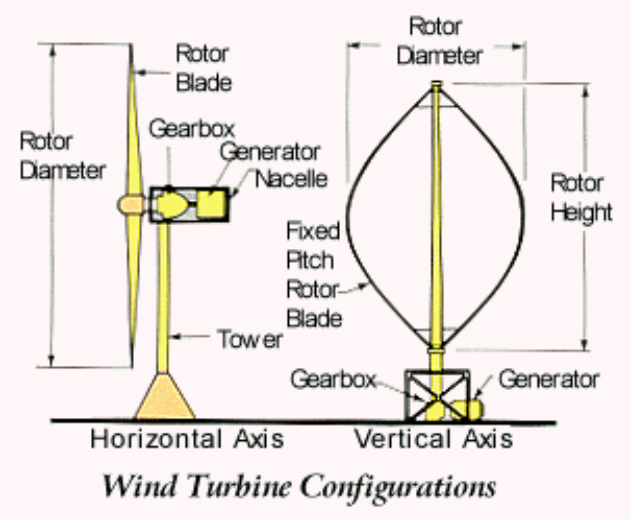
Auxiliary and Supplemental Power Fact Sheet: Wind Turbines

DESCRIPTION

This fact sheet describes the use of Wind Turbines as Auxiliary and Supplemental Power Sources (ASPSs) for wastewater treatment plants (WWTPs). Wind turbines convert wind into mechanical energy and electricity. A generator is equipped with fan blades and placed at the top of a tall tower. The tower is tall in order to harness the wind at a greater velocity, free of turbulence caused by interference from ground obstacles such as trees, hills, and buildings. Generally, individual wind turbines are grouped into wind farms containing several turbines. Many wind farms are producing energy on a megawatt (MW) scale, ranging from a few MW to tens of MW.

The most common wind turbine is a horizontal-axis wind turbine. Horizontal-axis wind turbines typically have three blades and are operated with the blades facing the wind (upwind). The wind rotates the blades which in turn spin a shaft attached to a generator. A gear box connects the low-speed turbine shaft to the high-speed generator shaft. These gears increase the rotational speeds from about 30 to 60 rotations per minute in the turbine shaft to about 1,200 to1,500 revolutions per minute (the rotational speed required by most generators) in the generator shaft. The rotational energy produced by the shaft spins copper coils within a magnet housed in the generator. This magnet excites the electrons in the wire, producing electricity. The quantity of electricity depends on how fast the shaft can spin in the magnetic field, the strength of the magnetic field, and the quantity and arrangement of the copper coils. To produce electricity at relatively low costs, the shaft must rotate at high speeds. Horizontal axis turbines also include a computer operated yaw drive that turns the rotor so that as the wind direction changes, the turbines always face into the wind. Vertical axis wind turbines are the secondary choice due to the pulsating torque produced during each revolution, and the difficulty of mounting the vertical axis on the towers.

Commercially available wind turbines range between five kW for small residential turbines and five MW for large scale utilities. Wind turbines are 20 to 40 percent efficient at converting wind into energy. The typical life span of a wind turbine is 20 years, with routine maintenance required every six months. Wind turbine power output is variable due to the fluctuation in wind speed; however, when coupled with an energy storage device, wind power can provide a steady power output. The use of control systems can also help level the variability.



Wind Turbine Configurations

ADVANTAGES AND DISADVANTAGES

One advantage to wind turbines is the price of power generated from wind farms. This energy production can be inexpensive when compared to other traditional power production methods,

depending on the size of the wind farm. The cost to generate the electricity decreases as the size of the farms increase. Wind turbines do not produce any harmful emissions or require any fuel product for operation. The land below each turbine can still be used for animal grazing or farming.

A disadvantage of wind turbines is the larger amount of land needed to support a wind farm and the difficulty in having a location with enough wind to produce maximum efficiency and power. Aesthetic problems are created when placing the turbines in areas of higher population density. Another possible disadvantage is the death of birds due to the spinning turbine blades. Studies are being conducted on this issue to determine the mortality rate and to improve the design to reduce bird contact.

COST

Large-scale wind farms can be installed for about $1,000/kW. The cost of electricity produced from wind farms depends on the annual capacity factor, location, wind quality, maintenance costs, and installation costs. The cost per kW for small-scale wind turbines is still relatively high, however, the cost per kW decreases as the size of the turbine increases.

REFERENCES

http://www.energy.ca.gov/distgen/equipment/wind/wind.html

http://www.eere.energy.gov/windandhydro/wind_how.html

http://en.wikipedia.org/wiki/Wind_turbine

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